Chapter 1
Maintenance Tests

Overview

The M Series has two checkout procedures: the operator's shift checklist and the extensive six-month maintenance tests checkout procedures.

Because the M Series units must be maintained ready for immediate use, it is important for users to conduct the Operator's Shift Checklist procedure at the beginning of every shift. This procedure can be completed in a few minutes and requires no additional test equipment. (See the ZOLL M Series Operator's Guide for the Operator's Shift Checklist.)

A qualified biomedical technician must perform a more thorough maintenance test checkout every six months to ensure that the functions of the M Series unit work properly. This chapter describes the step by step procedures for performing the six month maintenance test checkout. Use the checklist at the back of this document (ZOLL M Series Maintenance Tests Checklist) to record your results of the maintenance tests.

This chapter describes the following maintenance tests:

- 1. Physical Inspection of the Unit
- 2. Front Panel Button Test
- 3. 3, 5, and 12 Leads Test
- 4. Power Supply Test
- 5. Leakage Current Test
- 6. Paddles Test
- 7. Heart Rate Display Test
- 8. Calibrating Pulses on Strip Chart Test
- 9. Notch Filter Test
- 10. Heart Rate Alarm Test

- 11. Defibrillator Self Test
- 12. Synchronized Cardioversion Test
- 13. Shock Test
- 14. Summary Report Test
- 15. Advisory Message Test
- 16. Pacer Test
- 17. SpO_2 Monitor Test
- 18. $EtCO_2$ Monitor Test

Before You Begin the Maintenance Tests

- Assemble the tools or specialized testing equipment listed in the “Equipment You Need to Perform the Maintenance Tests” section shown below.
- Keep an extra fully charged ZOLL M Series battery available.
- Schedule an hour to conduct the entire maintenance test.
- Photocopy the checklist at the back of this document and use the copy to record your results. As you conduct each step of a procedure, mark the Pass/Fail/NA check boxes on your checklist and then save it for your maintenance file.
- Perform the tests in the order presented.
- Perform all the steps of each test procedure.
- Complete all the steps of the procedure before evaluating the test results.

Equipment You Need to Perform the Maintenance Tests

For testing purposes, you can substitute an equivalent device.

- Zoll Medical Electrode Adapter from Dynatech Nevada Inc. (DNI part number 3010-0378).
- Dynatech Impulse 4000 Defibrillator Analyzer with 1.06 software or higher.
- Bio-Tek® 601 Pro Series International Safety Analyzer.
- Bio-Tek® Index 2PFE SpO_2 Simulator or equivalent. (For SpO_2 units only.)
- Novametrix Medical Systems, Inc. Capnostat Simulator TB1265/7100 or equivalent. (For $EtCO_2$ units only.)

- ECG Simulator; 12 Lead Simulator for 12 Lead test (e.g., Symbio CS1201).
- Stop watch.
- Standard series II PC flash memory cards.
- PCMCIA card reader and PC.
- Zoll Data Control (ZDC) for Windows® software from Pinpoint Technologies, Version 1.5 or higher (no equivalent) or Zoll Data Control (ZDC) for DOS software, Version 5.5 or higher (no equivalent).
- Phillips #1 screwdriver.
- Phillips #2 screwdriver.
- Flatblade screwdriver.
- Needle nose pliers without teeth.
- Orange (wooden) sticks.

Equipment You Need for the M Series Options Maintenance Tests

- SpO_2 cable and sensor (if option is installed).
- $EtCO_2$ cable and sensor (if option is installed).
- Paddles.
- Printer Paper.
- Battery.
- AC line cord.
- 3 lead, 5 lead and 12 lead ECG cables. (12 lead cable needed if 12 lead option is installed.)

1.0 Physical Inspection of the Unit

Tools Needed None.

Test Setup None.

Observe this...		Pass/Fail
1.1	**Housing** Is the unit clean and undamaged?	o o
1.2	Does the unit show signs of excessive wear?	o o
1.3	Does the handle work properly?	o o
1.4	Does the recorder drawer open and close properly?	o o
1.5	Are input connectors clean and undamaged?	o o
1.6	Are there any cracks in the housing?	o o
1.7	Do the front panel or selector switches have any damage or cracks?	o o
1.8	Are there any loose housing parts?	o o
1.9	Do the paddle latches work properly?	o o
1.10	**Paddles** Do the adult and pedi plates have major scratches or show signs of damage?	o o
1.11	Do the adult shoes slide on and off easily to expose the covered pedi plates?	o o
1.12	Are the paddles clean (e.g., free of gel) and undamaged? (if applicable)	o o
1.13	**Cables** Are all cables free of cracks, cuts, exposed or broken wires?	o o
1.14	Are all bend/strain reliefs undamaged and free of excessive cable wear?	o o

Observe this...		Pass/Fail
1.15	**Battery** Is the ZOLL battery fully charged?	o o
1.16	Is the battery seated in the battery well correctly?	o o
Record your results on the Maintenance Test Checklist.		

2.0 Front Panel Button Test

Tools Needed

None.

Test Setup

Do the following:

- Install strip chart paper into the recorder tray.
- Install the battery in the unit or connect the A/C power cord to the unit and then plug the cord into an electrical outlet.
- Connect the universal cable and ECG cable (3 lead, 5 lead, or 12 lead) to the ZOLL simulator, or Dynatech Impulse 4000 Analyzer (or equivalent).

	Do this...	**Observe this...**	**Pass/Fail/NA**
2.1	Turn the selector switch to **MONITOR**. (For AED units, turn the selector switch to **ON** and select Manual mode.)	Listen for 4 beep tones. PADS and MONITOR display on the monitor. NOTE: PADS is a factory default setting.	o o
2.2	Press the **LEAD** button; three times for the 3 lead cable and seven times for the 5 lead cable.	Each time you press the LEAD button, a different lead number appears under the LEAD heading on the display. PADS, I, II, III will display a 3 lead ECG cable if connected or no ECG cable is connected. PADS, I, II, III, AVR, AVL, AVF, V1 will display a 5 lead ECG cable.	o o
2.3	Connect the 12 lead cable to unit and simulator. Press the **LEAD** button and select the lead for each of the 12 lead settings.	A 12 Lead cable will display PADS, I, II, III, AVR, AVL, AVF, VI, V2, V3, V4, V4, V5, V6.	o o o
2.4	Set the simulator to NSR of 120 BPM. To check the size of the ECG waveform, press the **SIZE** button.	As you press the SIZE button five times (0.5, 1.0, 1.5, 2.0, 3.0), note that the size of the ECG waveform appropriately changes on the display.	o o o

	Do this...	Observe this...	Pass/Fail/NA
2.5	Press the **ALARM SUSPEND** button.	Bell changes from disabled to enabled. If the alarm sounds, press the ALARM SUSPEND button to turn it off. The alarm will only be suspended for 90 seconds at this point. Press and hold the ALARM SUSPEND button for 3 seconds to disable alarms.	o o o
2.6	Press the **RECORDER** button (if equipped).	The strip chart paper moves out of the unit from the paper tray. Check that the correct time, date, ECG lead annotation and waveform are recorded on the paper. (Set Time and Date, if necessary.)	o o o
2.7	Open the paper tray. Press **RECORDER** button.	CHECK RECORDER message appears on the monitor.	o o o
2.8	Close the paper tray. Press **RECORDER** button.	Strip chart paper flows out of paper tray. Verify that the CHECK RECORDER message no longer displays.	o o o
2.9	Press **RECORDER** button.	Strip chart paper stops flowing out of paper tray.	o o o
2.10	Press the **VOLUME** softkey. To increase the volume of the beep, press the **Inc**. softkey.	The volume bar graph displays. Audible beep when the QRS wave displays. The bar graph increases on the display indicating an increase in volume. This action does not increase the volume which is normal. Note: The QRS tone is on or off. There is no gradual change in volume. If equipped, voice prompts are gradual. Note: The voice volume has 5 settings. Setting 3 is in the mid-range.	o o
2.11	To decrease the volume of the beep, press the **Dec**. softkey.	The bar graph decreases on the display indicating a decrease in volume. The volume shuts off at the last bar; otherwise, the volume is the same as originally set.	o o
2.12	Press the **CONTRAST** button.	Contrast menu displays.	o o

	Do this...	Observe this...	Pass/Fail/NA
2.13	(For LCD monitors only.) Press the **CONTRAST** button. To increase the contrast of the display, press the **Inc**. softkey.	Background light and characters display. The contrast increases on the monitor display (LCD). The brightness increases on the monitor display (EL). The bar graph increases on the display indicating an increase in contrast. **NOTE** Electro luminescence (EL) displays have only two settings independent of the bar graph without any gradual changes. If EL brightness is already set to its highest level, brightness will not change.	For LCD monitors o o o o o o
2.14	To decrease the contrast of the display, press the **Dec**. softkey.	The bar graph decreases on the display indicating a decrease in contrast (LCD) and brightness (EL). The display contrast and brightness changes.	o o
2.15	Press the **SUMMARY** button (if available).	Summary menu displays on the monitor showing the summary report options.	o o o
2.16	Press the **CODEMARKER** button (if available).	Code marker menu displays.	o o o
2.17	Connect A/C current and install the battery. Turn the unit off.	CHARGER ON indicator lights. The amber or green lights illuminate. Note: If both lights flash ON/OFF, the unit is defective or no battery is installed.	o o o
2.18	If applicable, connect D/C current and install the battery. Turn the unit off.	CHARGER ON indicator lights. The amber or green lights illuminate. The yellow light indicates the battery is being charged. The green light indicates the battery is fully charged to present capacity. **NOTE** If both lights flash ON/OFF, the unit is defective or no battery is installed.	o o o
2.19	Remove the battery.	Note that both charge lights (green and amber) flash alternately.	o o
2.20	Replace the battery and the turn unit on.	Note that the yellow charge light illuminates.	o o

	Do this...	Observe this...	Pass/Fail/NA
2.21	Press the **ANALYZE** button (if available).	SELECT DEFIB MODE message appears on the monitor. (For manual devices.)	o o o
2.22	Move the selector switch to DEFIB. Select 2J. Press the **CHARGE** button.	The display shows that the unit is charging. The SHOCK button lights when the unit is charged. Ready tone for DEFIB sounds.	o o o
2.23	Press and hold the **ENERGY SELECT** down arrow.	Unit discharges internally and selected energy decrements to 1J.	o o o
2.24	Press and release the **ENERGY SELECT** up arrow 19 times.	The following energy amounts display incrementally 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 50, 75, 100, 150, 200, 300, 360J (for DSW). Biphasic: 1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200J.	o o o
2.25	Press the **CHARGE** button.	Note the display shows the unit charged up to 360J (200J - Biphasic) and the SHOCK button lights.	o o o
2.26	Press the **SHOCK** button.	The unit discharges and the SHOCK button is no longer lit. A 15 second strip chart automatically prints, displaying the number of joules delivered (if equipped with recorder).	o o o
Record your results on the Maintenance Test Checklist.			

3.0 3, 5, and 12 Leads Test

Tools Needed

3 lead, 5 lead, and 12 lead cables.

Test each cable separately.

Test Setup

Note: The M Series unit must be configured to display ECG LEAD OFF message.

Connect the lead wires appropriate to each test to the Dynatech Impulse 4000 or equivalent (Symbio CS1201).

	Do this...	**Observe this...**	**Pass/Fail/NA**
3.1	Turn the selector switch to **MONITOR**. Select leads.	NO ECG LEADS OFF message displayed.	o o o
3.2	Disconnect one lead from the simulator.	The ECG LEAD OFF message displays within 3 seconds (if configured).	o o o
3.3	Reconnect the lead. Repeat step 3.2 with the remaining leads.	Wait for ECG LEAD OFF message to clear from the display (if configured).	o o o
3.4	Repeat 3.2 and 3.3 for 5 lead and 12 lead cables.	NOTE: If heart rate alarm sounds, press and hold the ALARM SUSPEND button for 4 seconds to disable the alarms. NOTE: When testing the 12 lead cable, the ECG LEAD OFF message displays when you pull off a limb lead. When you pull off a V lead, the ECG VX LEAD OFF message displays where “X” is the number between 1 and 6.	o o o
Record your results on the Maintenance Tests Checklist.			

4.0 Power Supply Test (Optional)

Tools Needed

2 red miniature alligator to miniature alligator leads.

1 black miniature alligator to miniature alligator test lead.

DC power supply (15 Amp minimum).

0.1Ω 1% resistor (¼W or greater).

1000Ω 1% ¼W resistor.

Fluke 75 multimeter or equivalent.

Test Setup

Make sure the unit and power supply are turned off.

Connect one end of the black lead to the "-" terminal in the battery well.

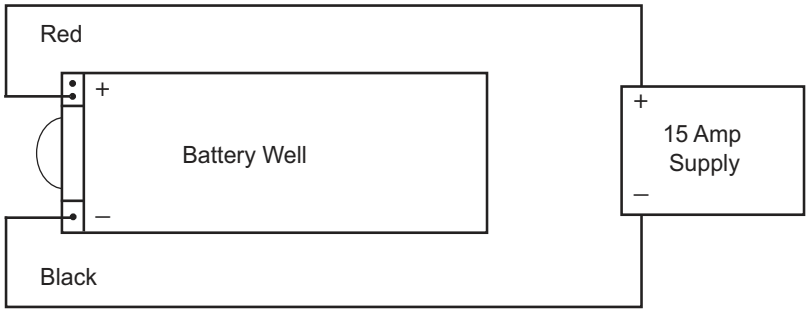
Connect the other end of the black lead to the "-" terminal of the power supply.

Connect the red lead to "+" terminal socket of the battery well. Use the middle pin with the plastic guard around it.
Connect the other end of the red lead to the "+" terminal of the power supply.

Set the power supply voltage to 7V.

CAUTION

Be sure to connect the power supply properly to the M Series battery well terminals or damage to the unit may result.
Do NOT raise the power supply voltage above 12V.



	Do this...	Observe this...	Pass/Fail
4.1	Turn the selector switch to **MONITOR**. (For AED units, turn the selector switch to **ON** and select Manual mode.)	The unit should not turn on.	o o
4.2	Turn the unit off.		o o
4.3	Adjust the power supply voltage to 10.3V and turn the selector switch to **MONITOR** (for AED units, turn the selector switch to **ON**).	The unit should turn on.	o o
4.4	**Low Battery Test** Set voltage to 9.8V.	No LOW BATTERY message displays.	o o
4.5	Set voltage to 9.3V.	LOW BATTERY message displays within 30 seconds.	o o
4.6	**Shut Down Voltage Test** Set voltage to 8.5V.	Unit should shut off within 30 seconds.	o o
Record your results on the Maintenance Tests Checklist.			

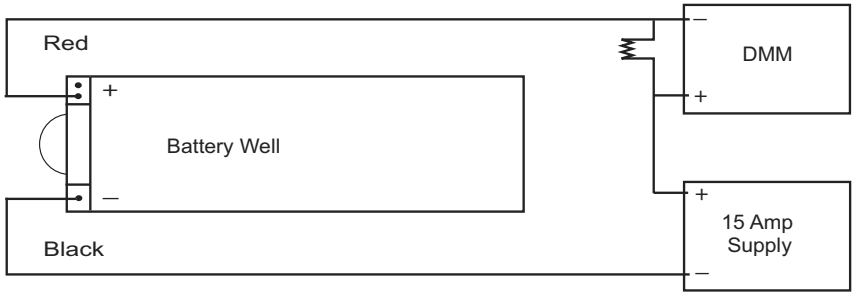
Test Setup

Remove red lead from power supply and connect to 0.1Ω resistor.

Connect other end of resistor to "+" terminal of power supply using a second red lead.

Connect multimeter across the resistor.

Set voltage scale (if DVM is not autoranging) to 220 mV.



	Do this...	Observe this...	Pass/Fail/NA
4.7	**System Current Test** Set power supply to 10.3V.		
4.8	Turn the selector switch to **MONITOR**. (For AED units, turn the selector switch to **ON** and select Manual mode.)	Voltage across resistor should be 80 mV or less (<800 mA of ON current). NOTE: Without optional parameters. a) With green screen or LCD and no options <80mV b) With yellow screen and no options <81mV c) With yellow screen and SpO_2 <104mV d) With yellow screen and voice recording <91mV e) With yellow screen, voice recording and SpO_2 <114mV f) All devices with $EtCO_2$ <121mV	o o o o o o o o o o o o o o o o o o o o o
4.9	Turn unit off.		o o
Record your results on the Maintenance Tests Checklist.			

Test Setup for Off Current Test

Remove 0.1Ω resistor and replace with 1KΩ

Connect DMM across resistor.

Set voltage scale to DCV.

Measure voltage across resistor.

	Do this...	Observe this...	Pass/Fail
4.10	**Off Current Test** Measure across resistor with unit turned off.	Voltage should be less than 450 mV (<450 µA of current).	o o
Record your results on the Maintenance Tests Checklist.			

5.0 Leakage Current Test

Tools Needed

See the manufacturer's instructions or supplied specifications for the leakage tester you use.

Setup

See the manufacturer's instructions or supplied specifications for the leakage tester you use. Repeat leakage test with accessories: MFC, external paddles, internal paddles, and anterior/posterior paddles.

Maximum Leakage Acceptance Limits		
	Normal Condition	Single Fault Condition*
ECG	10µA	50µA
MFC	100µA	100µA
Earth	500µA	1000µA
*Single fault considered AC mains on applied part.		

6.0 Paddles Test

Tools Needed

None.

Test Setup

If applicable, connect the universal cable to the paddles. Place paddles in paddle wells.

	Do this...	Observe this...	Pass/Fail/NA
6.1	Turn the selector switch to **DEFIB**. Press and hold the **ENERGY DOWN** button on the sternum paddle.	The energy selection decreases to 1J.	o o
6.2	Press and release the **ENERGY UP** button on the sternum paddle for each setting.	The energy selection increases incrementally to 360J (2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 50, 75, 100, 150, 200, 300, 360J). Biphasic: 1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200J.	o o
6.3	Press and release the **RECORDER** button on the sternum paddle.	The recorder turns on. Press and release again to turn off.	o o o
6.4	Select 30J using the paddle **ENERGY** button. Press the **CHARGE** button on the Apex paddle.	The unit charges to 30J, then the red LED charge indicator illuminates and the charge tone sounds. (Note that the front panel shock button does not illuminate).	o o
6.5	Press and release the **APEX SHOCK** button.	No discharge.	o o
6.6	Press and release the **STERNUM SHOCK** button.	No discharge.	o o
6.7	Press and hold both paddles **SHOCK** buttons.	The unit discharges. The TEST OK message displays and the red LED turns off. The recorder runs.	o o
Record your results on the Maintenance Tests Checklist.			

7.0 Heart Rate Display Test

Tools Needed

Calibrated ECG simulator with 60Hz sine wave output capability.
Mini-phone plug for measuring output signal from **1 Volt ECG OUT** jack (optional).
ECG Cable (3 or 5 leads).

Test Setup

Turn the selector switch to **MONITOR**. Press LEAD button until “I” displays.
Connect the ECG leads to the DYNATECH Impulse 4000 or equivalent.
Connect the ECG cable to the unit.

	Do this...	**Observe this...**	**Pass/Fail/NA**
7.1	Set the ECG Simulator to 120BPM.	The Heart Rate displays as 120 +/- 2 bpm	o o o
Record your results on the Maintenance Tests Checklist.			

8.0 Calibrating Pulses on Strip Chart Test

Tools Needed: None.

Test Setup: None.

	Do this...	Observe this...	Pass/Fail/NA
8.1	Press the **RECORDER** button.		
8.2	Press and hold **SIZE** button to activate the calibration signal.	The strip chart displays a signal of 300 ppm with an amplitude of 10 mm +/- 1 mm. The signal also appears on the video display.	o o o
Record your results on the Maintenance Tests Checklist.			

9.0 Notch Filter Test

Tools Needed

Dynatech Impulse 4000 (or equivalent).

Test Setup

Connect the ECG cable to the DYNATECH Impulse 4000 or equivalent.

Connect the ECG cable to the unit.

	Do this...	Observe this...	Pass/Fail/NA
9.1	Turn the selector switch to **MONITOR** mode. (For AED units, turn the selector switch to **ON** and select Manual mode.)		
9.2	Select lead I, size 3x. Select 60Hz (or 50 Hz for a 50Hz unit) on the Dynatech Impulse 4000.		
9.3	Press **RECORDER** button.	Verify that the waveform amplitude on the strip chart is less than 1.5 mm.	o o o
9.4	Turn the ECG simulator off.		
Record your results on the Maintenance Tests Checklist.			

10.0 Heart Rate Alarm Test

Tools Needed

Dynatech Impulse 4000.

	Do this...	Observe this...	Pass Fail/NA
10.1	Turn the selector switch to **MONITOR** mode. (For AED units, turn the selector switch to **ON** and select Manual mode.) Connect the ECG leads to the Dynatech Impulse 4000. Set the simulator to 120 BPM and the defibrillator to lead II.	Lead II message displays. NSR ECG at 120 BPM +/- 2 displayed.	o o o
10.2	Press **ALARMS**.	The alarm menu displays.	o o o
10.3	Press **SELECT PARAM** softkey until ECG HR displays.	Cursor scrolls through parameters.	o o o
10.4	Press **INC>** for state.	Cursor scrolls through ENABLE, AUTO and DISABLE.	o o o
10.5	Press **DEC>**for state.	Cursor scrolls through ENABLE, DISABLE, AND AUTO.	o o o
10.6	Press **INC**> until ENABLE displays.	ENABLE displays.	o o o
10.7	Set LOW limit to 30, HIGH limit to 150 then, press the **RETURN** softkey.	MONITOR displays.	o o o
10.8	Press **ALARM SUSPEND** button.	No alarm sounds.	o o o
10.9	Remove a lead wire from the Dynatech Impulse 4000.	The bell symbol flashes and the heart symbol stops flashing. The ECG LEAD OFF alarm tone sounds. Recorder prints a stripchart showing a low heart rate, if enabled.	o o o

	Do this...	Observe this...	Pass Fail/NA
10.10	Reattach ECG Lead wire to Dynatech Impulse 4000 and hold the **ALARM SUSPEND** button on unit for 4 seconds.	The bell symbol has an “X through it. The heart symbol flashes with each QRS wave.	o o o
10.11	Press the **ALARM SUSPEND** button.	Alarm is enabled. Bell symbol (without “X”) displays.	o o o
10.12	Set simulator to 160 BPM or higher.	Heart Rate Value is highlighted, alarm tone sounds, the bell and the heart symbol both flash.	o o o
10.13	Press the **ALARM SUSPEND** button in the unit.	Alarm is suspended for 90 seconds. The bell symbol has an “X” through it. The heart symbol flashes with each QRS wave.	o o o
10.14	Press and hold **ALARM SUSPEND** for 4 seconds to disable alarms.		o o o
Record your results on the Maintenance Tests Checklist.			

11.0 Defibrillator Self Test

SHOCK HAZARD!

TAKE THE NECESSRY PRECAUTIONS TO GUARD AGAINST SHOCK OR INJURY BEFORE YOU START CONDUCTING THE DEFIRBILLATOR TESTS.

Keep hands and all other objects clear of the multi-function cable connections and defibrillator analyzer when discharging the defibrillator.

Before you discharge the defibrillator, warn everyone near the equipment to STAND CLEAR.

CAUTION Do NOT internally discharge the unit more than 3 times in 1 minute. Note that multiple rapidly repeating internal discharges at more than 30 Joules may damage the unit.

Tools Needed

MFC Test Port Connector 1004-0053-99 with universal cable.

MFC Test Adaptor Connector (Dynatech Nevada Part Number 3010-0378 or equivalent).

Dynatech Impulse 4000 or equivalent defibrillator analyzer.

ECG Cable.

Stop watch.

Test Setup

Ensure the unit is turned off and the ECG cable is connected to the unit and analyzer. The universal cable should not be connected to any equipment at the beginning of this test.

	Do this...	Observe this...	Pass/Fail
11.1	Turn the selector switch to **DEFIB** mode. (For AED units, turn the selector switch to **ON** and select Manual mode.) Set leads to PADS.	CHECK PADS/POOR PAD CONTACT message displays.	o o

	Do this...	Observe this...	Pass/Fail
11.2	Connect the universal cable to the MFC test port.	DEFIB PAD SHORT message displays.	o o
11.3	Select energy level of 100J and press the **CHARGE** button.	The charge time is >2 second and <10 seconds and SELECT 30J FOR TEST is displayed.	o o
11.4	Press the **SHOCK** button.	Unit does not discharge. DEFIB PAD SHORT message displays.	o o
11.5	Set energy level to 30J.	Unit internally discharges.	o o
11.6	Press the **CHARGE** button.	Unit charges to 30J and displays DEFIB 30J READY. The charge ready tone sounds.	o o
11.7	Press and hold **SHOCK** button.	Unit discharges. TEST OK message and number of joules delivered message displays. For example, using the message at the top of the printed strip chart would read as follows: For monophasic unit: 30 JOULES TEST OK. 37-47A JOULES DEL=30 IMPED=0. For Biphasic Unit: 30 JOULES TEST OK. TEST_CUR=10-14A DEFIB_IMPED=0. **NOTE** The impedance value may range from 0 to 5Ω.	o o
Record your results on the Maintenance Tests Checklist.			

12.0 Synchronized Cardioversion Test

Tools Needed

Dynatech Impulse 4000 or equivalent defibrillator analyzer.

Test Setup

Connect the universal cable via the adapter (D.N.I #3010-0378) to the defibrillator analyzer.

Select cardioversion on analyzer. Input 1mV ECG signal at 60 -120 BPM.

	Do this...	**Observe this...**	**Pass/Fail**
12.1	Press **LEAD** button to select **PADS** and Size X1.		
12.2	Press the **SYNC** softkey on the defibrillator. Enter synchronized cardioversion timing test mode on the defibrillator analyzer.	Sync appears on display. Sync markers display on the monitor. The sync marker appears as a down arrow over the ECG R-wave peaks on strip chart and display.	o o
12.3	Select 360J (200J for Biphasic unit).		
12.4	Press the **CHARGE** button. When the **SHOCK** button lights, press and hold the **SHOCK** button.	Observe that the R-wave to shock delay (sync delay) is less than 60 milliseconds on the analyzer display. Defibrillator discharges.	o o
Record your results on the Maintenance Tests Checklist.			

13.0 Shock Test

Tools Needed

Dynatech Impulse 4000 or equivalent defibrillator analyzer.

Test Setup

Stop watch.

Connect the universal cable via the adapter (D.N.I #3010-0378) to the defibrillator analyzer.

Ensure that a fully charged battery is installed in the unit.

NOTE: If your M Series AED does not have manual override capability, do not perform this test.

	Do this...	**Observe this...**	**Pass/Fail/NA**
13.1	Turn the selector switch to **DEFIB** mode. (For AED units, turn the selector switch to **ON** and select Manual mode.)		o o o
13.2	Press the **ENERGY SELECT** down arrow until 1J displays.	DEFIB 1J SEL displays.	o o o
13.3	Press the **CHARGE** button.Wait for the **SHOCK** button to illuminate.	DEFIB 1J RDY displays.	o o o
13.4	Press the **SHOCK** button.	Unit discharges 0J-2J into the simulator. (Note: The displayed rhythm may change shape for 30 seconds before it returns to an original rhythm. This is caused by the operation of the adaptive bandwidth defibrillator recovery circuit.)	o o o
13.5	Repeat for all settings 1-300J (DSW); 1-150J (Biphasic)	Energy delivered is within + /- 15% or 2J of setting which ever is greater.	o o o
13.6	Press the **ENERGY SELECT** up arrow until 360J (200J for Biphasic) displays.	DEFIB 360J SEL displays or DEFIB 200J SEL displays (for Biphasic unit).	o o o

	Do this...	Observe this...	Pass/Fail/NA
13.7	Press the **CHARGE** button and start timing with a stopwatch. Stop timing when the **SHOCK** button illuminates.	Observe and record the value of the charge time on the stop watch. Charge time (DSW) 4.0-8.0 sec. Charge time (Biphasic) 3.0-6.0 sec.	o o o
13.8	Press the **SHOCK** button. Record the value of the discharge energy that is displayed on the analyzer.	360J discharge energy (DSW) 306-414J. 200J discharge energy (Biphasic)170-230J.	o o o
13.9	(Biphasic unit only) Note the Patient Current and Defib Impedance on the strip chart.	Patient Current 22-24A. Defib Impedance 46-54 Ohms.	o o o
13.10	(AED unit only) Disconnect the cable from the analyzer.	CHECK PADS audio prompt.	o o o
Record your results on the Maintenance Tests Checklist.			

14.0 Summary Report Test (if applicable)

Tools Needed

None.

Test Setup

Connect the universal cable to the defibrillator analyzer. If you are using paddles, place the paddles on the analyzer's discharge plates.

	Do this...	Observe this...	Pass/Fail
14.1	Press and hold the **SUMMARY** softkey for 4 to 8 seconds to erase any previously stored data.	ERASING REPORT displays.	o o
14.2	Set selector switch to **DEFIB**. Select 300J (200J for Biphasic) using the **ENERGY SELECT** button, and press the **CHARGE** button. When charged, press the **SHOCK** button to discharge into the defibrillator analyzer.	The unit successfully discharges and prints a strip chart.	o o
14.3	Wait 18 seconds, then press the **Code Marker** softkey. Press the **CPR** softkey.	The Code Markers display.	o o
14.4	Turn the unit off. Wait 10 seconds and then turn the unit on. Press the **SUMMARY** softkey, then press the **PRINT CHART** softkey.	Summary report prints. The report displays the correct date, time, the shock delivered and Code Marker event.	o o
Record your results on the Maintenance Tests Checklist.			

15.0 Advisory Message Test (for AED and Manual/Advisory Units)

Tools Needed

None.

Test Setup

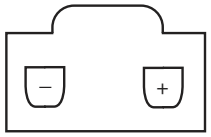
Connect the universal cable via the adapter (D.N.I #3010-0378), then attach to the defibrillator analyzer.

	Do this...	**Observe this...**	**Pass/Fail**
15.1	Connect universal cable to the simulator. Turn the selector switch to **DEFIB** mode. (For AED units, turn the selector switch to **ON**.)		
15.2	Select VF (ventricular fibrillation) on the simulator, then press the **ANALYZE** button.	ANALYZING ECG message displays. STAND CLEAR message displays.* SHOCK ADVISED message displays.* PRESS SHOCK message displays*+ *AED's audio prompts are standard. Advisory audio prompts are user configurable on later manufactured units. +If configured for auto charge.	o o
15.3	Press the **SHOCK** button.	Unit discharges.	o o
15.4	Select the **NSR** (normal sinus rhythm) on the simulator, then press the **ANALYZE** button.	ANALYZING ECG message. STAND CLEAR message.* NO SHOCK ADVISED message.* *AED's audio prompts are standard.	o o
Record your results on the Maintenance Tests Checklist.			

16.0 Pacer Test

Tools Needed

Dynatech Impulse 4000 Analyzer (software 1.06 or higher) with optional external plug in pacing module (TQA-17) or equivalent.



Note: The following tests are to be performed only on M Series units equipped with the optional pacing function.

The pacer output can be measured using an oscilloscope set to DC coupling connected across a load resistor. (See diagram in column for universal cable connector polarity.) The load resistor is a 100 ohm, 5 watt or greater. The pacer output is a positive going pulse, 40 +/- 2 ms duration with an amplitude of 0.1 volt per milliamp of selected output (e.g., 40 milliamps of selected output has an amplitude of 4 +/- 0.5 volts the specified tolerance displayed on the oscilloscope).

If an external non-invasive pacer analyzer is being used, then follow the manufacturer's guidelines for measuring the frequency (ppm), output (mA) and the pulse width measured in milliseconds. Note that the analyzer pace load resistor must be less than 250 ohms.

Test Setup

Connect the universal cable from the M Series to the External Pacer Load (TQA-17) of the Impulse 4000.

Turn the Main Selector knob of the M Series to the Pacer mode.

	Do this...	**Observe this...**	**Pass/Fail**
16.1	Set the **PACER OUTPUT** to 14 mA and disconnect MFC connector from the Dynatech Impulse 4000.	CHECK PADS AND POOR PAD CONTACT message displays. The pace alarm is active.	o o
16.2	Reconnect the universal cable to the Dynatech Impulse 4000. Press Clear Pace Alarm softkey.	CHECK PADS AND POOR PAD CONTACT message disappears. The pace alarm is cleared.	o o
16.3	Set rate to 180 ppm; output to 0mA.	No output appears on the Dynatech Impulse 4000.	o o
16.4	Increase the output to 20mA.	Output on the Dynatech Impulse 4000 is 20mA +/- 5mA. Pulse width is 40mS +/-2mS.	o o

	Do this...	Observe this...	Pass/Fail
16.5	Increase the output to 40mA.	Output on the Dynatech Impulse 4000 is 40mA +/- 5 mA. Pulse width is 40mS +/-2mS.	o o
16.6	Increase the output to 60mA.	Output on the Dynatech Impulse 4000 is 60mA or +/- 5mA. Pulse width is 40mS +/-2mS.	o o
16.7	Increase the output to 80mA	Output on the Dynatech Impulse 4000 is 80mA or +/- 5mA. Pulse width is 40mS +/-2mS.	o o
16.8	Increase the output to 100mA.	Output on the Dynatech Impulse 4000 is 100mA or +/- 5mA. Pulse width is 40mS +/-2mS.	o o
16.9	Increase the output to 120mA.	Output on the Dynatech Impulse 4000 is 120mA or +/- 6mA. Pulse width is 40mS +/-2mS.	o o
16.10	Increase the output to 140mA.	Output on the Dynatech Impulse 4000 is 140mA or +/- 7mA. Pulse width is 40mS +/-2mS.	o o
16.11	Decrease the output to 60mA. Decrease the rate to 30 ppm.	Pacer rate on Dynatech is 29-31 ppm.	o o
16.12	Increase the rate to 40ppm.	Pacer rate on Dynatech is 39-41 ppm.	o o
16.13	Increase the rate to 60ppm.	Pacer rate on is Dynatech is 59-61 ppm.	o o
16.14	Increase the rate to 80ppm.	Pacer rate on Dynatech is 78-82 ppm.	o o
16.15	Increase the rate to 100ppm.	Pacer rate on Dynatech is 98-102 ppm.	o o
16.16	Increase the rate to 120ppm.	Pacer rate on Dynatech is 118-122 ppm.	o o
16.17	Increase the rate to 180ppm.	Pacer rate on Dynatech is 177-183 ppm.	o o
16.18	Decrease the rate to 50 ppm.	Pacer rate on Dynatech is 49-51 ppm.	o o

	Do this...	Observe this...	Pass/Fail
16.19	Connect the ECG cable to the M Series and Dynatech Impulse 4000. Select the ECG at 60 BPM on the Dynatech Impulse 4000.	ECG at 60 BPM is seen on the display and no stimulus markers.	o o
16.20	Press the Async Pace softkey.	ECG at 60 BPM seen on the display with the pace stimulus markers displayed. Async pace message displays.	o o
16.21	Turn off Dynatech. Set Pacer Rate to 100ppm. Press the **RECORDER ON** button.	Observe the pace stimulus markers every 15mm +/-1mm.	o o
16.22	Press and hold 4:1 button.	Observe the pace stimulus markers every 60 mm+/- 1.5 mm.	o o
Record your results on the Maintenance Tests Checklist.			

17.0 SpO_2 Monitor Test for SpO_2 Option

Tools Needed

Masimo® Reusable Sensor.

Masimo® Patient Cable.

Bio-Tek Index 2PFE SpO_2 Simulator (or equivalent).

Test Setup

Connect the universal cable to the MFC test plug.

DO NOT connect the ECG cable to the simulator.

Install the Masimo® Patient Cable and attach the Masimo® sensor to the patient cable.

Connect the Masimo® sensor to the finger simulation post.

Place a fully charged battery into the battery well or connect to AC power (DC power, if equipped).

Ensure that the SpO_2 Simulator is off.

	Do this...	**Observe this...**	**Pass/Fail**
17.1	Turn the selector switch to **MONITOR**. (For AED units, turn the selector switch to **ON** and select Manual mode.)	The SpO_2 saturation percentage appears as a dashed line on the monitor.	o o
17.2	Wait ten seconds. Turn on the SpO_2 simulator. Press the **SIM** softkey on the Index SpO_2 Simulator. Press the **MAN** softkey.	The SpO_2 PULSE SEARCH message displays.	o o
17.3	Press the **02+** or **02-** softkey of the simulator until the SpO_2 output is at 98%.	The M Series SpO_2 reading of 98 +/- 1% appears on the M Series monitor. Note that you may need to wait up to 2 minutes for the information to appear on the ZOLL display.	o o

	Do this...	Observe this...	Pass/Fail
17.4	Using the Index SpO_2 Simulator, press the **BPM+** or **BPM-** softkey until the heart rate is 230 BPM.	The SpO_2 rate 230 BPM displays on the simulator screen. Note that you may need to wait up to 2 minutes for the information to appear on the ZOLL display. The SpO_2 saturation of 96-100% appears on the M Series display. The heart rate of 226-234 BPM displays on the M Series monitor.	o o
17.5	Using the Index SpO_2 Simulator, press the **BPM-** softkey until the heart rate is 50 BPM	The SpO_2 saturation of 96-100% displays on the unit. The heart rate of 46-54 BPM displays on the M Series monitor.	o o o o
17.6	Using the Index SpO_2 Simulator, press the **02+** softkey until the SpO_2 output is at 72%.	The SpO_2 saturation of 70-74% displays on the unit. The heart rate of 46-54 BPM displays on the M Series monitor.	o o o o
17.7	Press Wave 2 softkey. Select the SpO_2 waveform.	Plethysmographic waveform appears on the ZOLL display.	o o
17.8	Press **RECORDER**.	The plethysmographic waveform prints on the strip chart paper.	o o
17.9	Using the Index SpO_2 Simulator, press the **BPM-** softkey until the heart rate is at 230 BPM.	The SpO_2 saturation rate of 70-74% displays on the unit. The heart rate in the heart position of 226-234 BPM displays on the monitor.	o o
17.10	Select Wave 2 SpO_2.	Verify that the waveform is displayed at the correct rate. Print the waveform.	o o
17.11	Remove the Masimo® patient cable.		
Record your results on the Maintenance Tests Checklist.			

18.0 $EtCO_2$ Monitor Test (for $EtCO_2$ Option)

Tools Needed

Novametrix Capnostat Simulator Tb 1265/7100.

Test Setup

Install the battery.

On the Novatrix Simulator, set the following:

Set inspired CO_2 to OFF.

Set% CO_2 to 0.

Set Sensor Location to ZERO CELL.

Set Source Current to NORMAL.

Set CO_2 mode to CONTINUOUS.

Set Temperature to NORMAL.

	Do this...	**Observe this...**	**Pass/Fail**
18.1	Turn the selector switch to **MONITOR** mode. (For AED units, turn the selector switch to **ON** and select Manual mode.)		
18.2	Attach the $EtCO_2$ simulator to the M Series input connections.	CO_2 SENSOR WARMUP message displays. Note: You may need to wait up to 5 minutes for the warm-up message to disappear. If the message REPLACE CO_2 SENSOR displays, reinsert the Novametrix Simulator Cable. Note that the message ZEROING CO_2 SENSOR may display for an additional 20 seconds. Automatic zeroing will occur if the unit had not been zeroed at the time of its last use.	o o
18.3	On the Novametrix Simulator, set **SENSOR LOCATION** to **REF CELL.**	The $EtCO_2$ reading of 36-40 mmHg displays on the monitor. Note that you may need to wait up to 10 seconds for the unit to stabilize.	o o

	Do this...	Observe this...	Pass/Fail
18.4	On the Novametrix Simulator, set **SENSOR LOCATION** to **AA CELL.** Set% CO_2 to 10. Set CO_2 mode to **RESPIRATION**.	The $EtCO_2$ reading of 74-84 mmHg appears on the M Series display. Note that you may need to wait up to 10 seconds for the unit to stabilize.	o o
18.5	On the Novametrix Simulator, set% CO_2 to 5.	The $EtCO_2$ reading of 34-42 mmHg displays on the M Series monitor. Note that you may need to wait up to 10 seconds for the unit to stabilize. The Respiration Rate (RR) of 22-24 displays on the M Series monitor. Press WAVE 2 softkey. The $EtCO_2$ waveform displays. Press RECORDER button. The $EtCO_2$ waveform prints. Note that the CO_2 waveform is displayed and printed at 12.5 millimeters per second scale.	o o
Record your results on the Maintenance Tests Checklist.			